SOIL-APPLIED LINDANE TO PROTECT KIWIFRUIT FROM GRASS GRUB BEETLE ATTACK

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SUMMARY

Lindane, broadcast onto soil in August, reduced grass grub beetle (*Costelytra zealandica*) numbers in kiwifruit plots (*Actinidia chinensis*) during the spring feeding flights, by 78% at 4 kg ai/ha and 60% at 2 kg ai/ha compared to untreated plots. Five foliar sprays of cypermethrin reduced beetle numbers by 60% and gave the best vine protection with 1-5% defoliation damage. Kiwifruit in the lindane treatments suffered 5-10% defoliation and untreated vines 20-40% damage. Lindane treated soil killed 58-67% of beetles which buried into soil cores for 2 h. It was concluded that damage in the lindane plots was caused by reinvasion of beetles into the small plots and that enhanced protection may be obtained when lindane is applied over a large orchard area.

INTRODUCTION

Spring feeding flights of grass grub beetles can cause severe defoliation of young kiwifruit vines resulting in a loss of 65% of summer cane growth (Blank and Olson 1984). Many other fruit crops such as tamarillo, avocado, blueberries, peaches and plums are also attacked. Synthetic pyrethroid insecticides applied 3-4 times at 7 day intervals over the main beetle feeding period provided the best insecticidal control on kiwifruit and blueberries (Blank and Olson 1984, East and Holland 1984). The timing of spray applications to coincide with the onset of feeding flights is crucial to achieving successful protection, as the killing activity of synthetic pyrethroids declines markedly after 5 days (Blank and Olson 1984). Additional problems exist with the use of synthetic pyrethroids on some crops which are in flower over the beetle flight season because of bee toxicity. Fruit residue tolerances have not yet been set for synthetic pyrethroids on overseas markets.

This study investigates a different approach to controlling grass grub beetles through the use of soil-applied insecticides. This approach utilizes the feeding behaviour of the beetles which, after feeding at night, drop to the ground and bury in the soil.

MATERIALS AND METHODS

The methods and kiwifruit orchard used to evaluate soil applications of lindane and foliar cypermethrin sprays as protectants against grass grub attack were as described in Blank and Olson (1984). Lindane (Shell Lindane Pellets 20%) as a blanket application was applied on 28 August 1984, using a vicon varispreeder PS400 with a fine application kit and a 5 m effective swath. Soil moisture in the top 30 mm was 69% (w:w) at application and 158 mm of rain fell between application and 12 October 1984. Cypermethrin (Ripcord 20EC) plus Agral LN (50 mls/100 litres) was applied on 23 and 30 October; 6, 13 and 20 November. Plot size was 35 × 26 m. The four treatments (Table 1) were randomised among six replicates. Beetle activity on vines was monitored from two trays (480 × 280 mm) placed on the ground under foliage in the central region of each plot.

The toxicity of two 100 mm diameter soil cores per plot was evaluated by placing four beetles/core in an inverted, clear plastic jar (50 mm diameter). Beetles were allowed to burrow into the soil cores which had closely clipped foliage, and were recovered after 2 h, when mortality was assessed (Blank *et al* 1983). This soil bioassay test was carried out on 23 November 1984.

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TABLE 1: Kiwifruit foliage damage from grass grub attack. The damage scale is the average assessment of 4 male, 4 large and 4 small female vines per plot.

Treatment	Damage score	% defoliation
untreated	3.6	20-40 moderate
lindane 2 kg ai/ha	2.2	5-10 slight
lindane 4 kg ai/ha	2.1	5-10 slight
cypermethrin 10 g ai/100 litres	1.2	1-5 trace
standard error of difference	0.3	—

RESULTS

The first major beetle feeding flight commenced on the night of 25 October. This coincided with the first major ground tray catch of 0.8 beetles/tray (Fig. 1). This was 5 days later than the commencement of feeding flights at this site in 1983 (Blank and Olson 1984). Feeding activity was greatest over the early November period and declined after 16 November (Fig. 1). Beetle activity as measured by tray catches on untreated ground was less than the levels encountered in 1983.

Fig. 1: Beetles recovered from trays under kiwifruit foliage. Insecticide application times are shown by arrows. The lindane 2 kg ai/ha treatment has been omitted to improve clarity. This treatment followed a similar pattern to the lindane 4 kg ai/ha.

Fig. 2: Dead (shaded) and live (unshaded) beetles recovered from trays under kiwifruit foliage following insecticide applications. Tray catches are the total for the 5 applications.

Beetle activity in the lindane and cypermethrin plots was significantly ($P < 0.01$) less than in untreated plots. The lindane 4 kg ai/ha plots had 78%, the lindane 2 kg ai/ha and cypermethrin 60% fewer beetles recovered in ground trays compared to untreated plots (Figs. 1 and 2). Insecticide treatments were unable to reduce beetle activity over the first major peak of beetle activity (4-6 November) but beetle numbers were subsequently contained at low numbers relative to the untreated plots. An exception was the cypermethrin treatment which on 12 November (night 6 after spraying) had a resurgence of beetle numbers (Fig. 1). Cypermethrin foliar sprays killed 80-90% of beetles recovered from trays over the first five nights but kills declined to 53 and 23% on the sixth and seventh nights respectively with an average mortality over the five nights of 55% (Fig. 2). Trays in the lindane and untreated plots had low levels of beetle mortality (7-17%).

Cypermethrin treated vines suffered significantly ($P < 0.01$) less damage than lindane treatments which had significantly ($P < 0.01$) less damage than untreated vines (Table 1).

The soil bioassay tests showed that the lindane-treated soil was toxic to the beetles with many recovered in the soil surface (Table 2).

TABLE 2: Toxicity of soil cores and the depth from which beetles were recovered after 2 h exposure.

Treatment	% mortality		% beetles at each depth (mm)		
	X	SEM	0	5-10	10-50
lindane 4 kg ai/ha	67	7	42	46	12
lindane 2 kg ai/ha	58	7	33	63	4
cypermethrin	8	4	13	62	25
untreated	15	5	6	78	16

DISCUSSION

Lindane was selected as being the most appropriate soil insecticide for use in this investigation. When broadcast on the soil it persists for long periods in the top 10 mm and is highly effective at killing grass grub beetles which burrow through the active lindane layer (Henzell *et al* 1981, Holland *et al* 1981, Lauren *et al* 1982). September applications of lindane (2 kg ai/ha) followed by low rainfall have given low levels of control and this was attributed to insufficient surface coverage of the 20 G formulation (Lauren *et al* 1984). Lindane at 4 kg ai/ha was included in these trials to ensure adequate coverage of the ground surface. Beetle tray catches in the 4 kg ai/ha plots were half

those of the 2 kg ai/ha plots (Fig. 2), but, both rates gave similar levels of foliage protection (Table 1) and mortality in the bioassay procedure (Table 2). The 158 mm of rainfall between application in late August and mid October thus appeared adequate to disperse both rates of lindane from the prill source.

In the soil bioassay beetles did not bury far into the soil (Table 2). To be fully effective lindane must, therefore, remain close to the soil surface. The active lindane layer appeared to be concentrated near the surface, as 88-96% of beetles in the lindane treated soil were found in the top 10 mm and a high proportion were subsequently found to be dead. The high proportion of beetles remaining on the surface of the lindane soil is consistent with the fumigant action of lindane (Holland *et al* 1981). Mortality in the bioassay test was evaluated after a single entry into the soil and a short 2 h exposure. This procedure avoided the multiple entry and exits which would have occurred from an overnight exposure. In the field situation beetles make two passes through the soil, an entry and exit, and remain in contact with the soil for at least 12 h. It is probable that field mortality is higher than the 58-67% achieved in the bioassay test and that most beetles are killed before the commencement of a second night's feeding.

Beetle activity was considerably reduced in the lindane plots but some damage still occurred. Beetles are highly mobile at dusk and, because of the relatively small size of plots, appeared to become randomly re-distributed amongst all plots resulting in nightly invasion into the lindane plots. Beetles were then able to feed all night before being killed. Cypermethrin treated vines give more effective protection because of a rapid knock down.

Lindane was applied to half of the 6 ha orchard and was probably a major factor in reducing beetle activity throughout the orchard as evidenced by the marked decline in beetle numbers in the lindane plots (Fig. 1). The protection obtained from lindane was acceptable under the moderate beetle attack that occurred. Lindane applications to large orchard blocks may enhance protection as reinvasion would be reduced.

These trials demonstrate that it is practical to use soil-applied lindane as the main line of defence to eliminate resident grass grub populations. A single soil application of lindane is more convenient and easier to apply than 3-5 foliar synthetic pyrethroid applications. A soil lindane application also overcomes problems relating to time of first application, multiple applications and associated weather constraints, fruit residues and bee toxicity. Foliar sprays may be used as, or if, required around the perimeter to control invasion. Synthetic pyrethroids are ideal for this purpose and even on crops lacking registration can be successfully applied to the grass sward to kill beetles (East and Willoughby 1985).

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REFERENCES

- Blank, R.H. and Olson, M.H., 1984. Insecticide protection of kiwifruit vines from attack by grass grub beetle. *Proc. 37th N.Z. Weed and Pest Control Conf.*: 130-135.
- Blank, R.H., Olson, M.H. and Bell, D.S., 1983. Screening insecticides to protect tamarillo against grass grub adults. *Proc. 36th N.Z. Weed and Pest Control Conf.*: 111-115.
- East, R. and Holland, P.T., 1984. Control of grass grub beetles in blueberries. *Proc. 37th N.Z. Weed and Pest Control Conf.*: 228-230.
- East, R. and Willoughby, B.E., 1985. Control of grass grub beetles in blueberries with pyrethroid insecticides. *Proc. 38th Weed and Pest Control Conf.*:
- Henzell, R.F., Lauren, D.R., du Toit, G.D.G. and Wrenn, N.R., 1981. Do soil applied insecticides control grass grub beetles? *Proc. 34th N.Z. Weed and Pest Control Conf.*: 234-238.
- Holland, P.T., Henzell, R.F. and Skinner, R.A., 1981. Insecticides for control of adult grass grub. IV. Comparative activity of insecticides in contact and soil bioassays. *Proc. 34th N.Z. Weed and Pest Control Conf.*: 239-242.

- Lauren, D.R. Hensell, R.F. and Wrenn, N.R., 1982. A comparison of lindane broadcast and drilled in spring for grass grub beetle control. *Proc. 35th N.Z. Weed and Pest Control Conf.*: 94-97.
- Lauren, D.R., Hensell, R.F., Wrenn, N.R. and Thomson, N.A., 1984. New approach and chemicals for grass grub adult control. *Proc. 37th N.Z. Weed and Pest Control Conf.*: 121-124.